CHAPTER 5

AN OVERVIEW OF COASTAL EROSION MANAGEMENT POLICY ALTERNATIVES FOR DEVELOPING COUNTRIES

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1.0 Introduction

Coastal erosion management refers to policies and physical interventions that are pursued to either prevent or reduce the impact of coastal erosion hazards. The coastal erosion management policies are statements of intent and directions that influence coastal managers to carry out all forms of physical interventions against erosion hazards along a given coastal jurisdiction.

Coastal defence is the general term used to covers all aspects of coastal schemes against coastal hazards (Reeve *et al*, 2004). Coastal defence thus covers all the physical interventions that are implemented to reduce coastal erosion. The two specific terms used to differentiate types of coastal defence are: sea defence and coastal protection. Sea defence defines all defence schemes which are mostly, constructed to prevent coastal flooding. Coastal protection on the other hand is schemes that are normally built to protect the coastline from further erosion.

There are two opposing approaches to the design of modern coastal defence schemes. They are soft engineering approach and hard engineering approach. The "pro" and "cons" of these approached have been extensively discussed by French 2001, Reeve *et al*, 2004 and DEFRA, 2006. The soft engineering design is mostly influenced by the knowledge and understanding of the natural processes. It is a defence scheme that imitates the natural defence system (e.g. beach nourishment/recharge, beach recycling, sandbag structures, dune grass planting). The hard engineering design refers to the heavy concrete structures and rock armour that are normally constructed

and storm surge). Example of hard engineering schemes includes sea wall, concrete groynes, rock armour, gabions and others.

Historically, coastal erosion management worldwide was dominated by "site specific" hard engineering approach (French, 2001). However, in recent times, an appreciation of the success of natural forces against past hard coastal defence schemes and improved knowledge on the natural coastal processes have influenced general approval towards holistic soft engineering approach. Coastal managers and experts nowadays prefer integrated soft engineering schemes to "site specific" hard engineering ones. In some countries, this preference has the support of policy and legislation, but the opposite of this general coastal erosion management policy preference exist in Ghana and in the West African sub-region.

Coastal erosion management in Ghana and many West African countries, up till date, remains 'ad hoc' and "site specific". Such management interventions (Keta sea defence, Ada sea defence and rock armour at Sakomo lagoon near Tema) are not based on the understanding of natural processes and therefore tend to protected sections being defended and exacerbate the problem elsewhere along the shoreline ("knock-on effects") (Boateng, 2006). In recent times, an appreciation of this effect, the success of natural forces against past hard coastal defence schemes and improved knowledge of the natural coastal processes have influenced a marked approval towards holistic soft engineering approach that mimic the natural processes. This chapter reviews and recommends the emerging coastal erosion management policies that are based upon the understanding for the natural processes and soft engineering schemes for Ghana and West Africa.

2.0 Coastal Erosion Management Policies

In the past decade, the anticipated increase in the intensity of coastal erosion as a result of potential impacts of climate change and associated sea level rise has resulted in the development of coastal erosion management policies in many coastal countries. IPCC (2001 and 2007) provides three generic coastal adaptation options as:

- accommodation and
- retreat

These policies are not only relevant to sea level rise but also coastal erosion management.

The Protection policy aimed at protecting the land from the sea so that existing land uses can continue, by constructing hard structures as well as using soft engineering measures. The first shortfall of protection policy is that it is generally costly and has limited long term effectiveness. The impact of protective structures is the "knock-on effect". Seawalls for instance, almost always cause terminal scour (out flanking) downdrift. Groynes also may succeed in trapping sediment updrift and cause starvation (erosion) of sediment downdrift and possibly lead to the continuous construction of expensive groynes or other forms of protective structure along the entire coastline.

The Accommodation policy implies that people continue to occupy the land but make some adjustments to properties and activities. The policy involves: redesigning of structures (e.g. elevating buildings and strengthening foundations) to minimise impact of flooding and erosion. The policy also includes land use policies such as zoning and coastal setback zones, to discourage capital investments on vulnerable lands. Other forms include soft approaches like dyke opening, wetland renewal, dune rehabilitation and beach nourishment to enhance natural resilience.

Retreat involves either only a partial, or perhaps no attempt to protect the land from the sea. In an extreme case, the coastal area is abandoned and coastal landforms and ecosystems are allowed to shift landwards. This policy option is recommended for highly vulnerable coastlines, where the market cost and/or technical difficulty of protecting the coast far exceeds the benefits of providing protection. To be effective, vulnerable populations and infrastructure need to be shifted away from hazardous zones.

The Dutch have always been fighting the sea, often winning this struggle, sometimes losing (Koster and Hillen, 1995). Until 1991, the Dutch coastal defence policy remains an ad-hoc policy. Protection schemes were only taken when the safety of life and properties at backshore was threatened. In 1989, a coastal protection working

group presented a discussion document which outlined four policy alternatives/options. They are:

- Retreat: coastal recession will only be counteracted at those locations where erosion threatens the safety of the people;
- Selective Preservation: intervention would not only be pertinent to those locations where the safety of the people is threatened, but also where major interests in the dunes or on the beach may be lost;
- Preservation: the entire coastline would be maintained at its 1990-location;
- Expansion Seaward: at locations of concentrated erosion, artificial defences extending into the sea would be built, bringing coastal recession to a standstill. Elsewhere along the coast, the 1990-coastline would be preserved.

The UK Department for Environment Food and Rural Affairs (DEFRA) in 2006 published coastal defence policy guidance outlined four strategic coastal defence/adaptation policy options to provide sustainable coastal defence. They are:

- Hold the existing defence line; by maintaining or changing the standard of protection. This policy should cover those situations where work or operations are carried out in front of the existing defences (such as beach recharge, rebuilding the toe of a structure, building offshore breakwaters and to improve or maintain the standard of protection provided by the existing defence line.
- Advance the existing defence line; by building new defences on the seaward side of the original defences. This policy should be limited to those management units where significant land reclamation is considered.
- Managed realignment; by allowing the shoreline to move backwards or forwards, with management to control or limit movement (such as reducing erosion or building new defences on the landward side of the original defences).
- No active intervention, where there is no investment in coastal

It must be noted here that the key to successful application of DEFRA (2006) strategic coastal defence options is based on sound understanding of coastal processes and the involvement of stakeholders to ascertain potential hazards, vulnerability, resilience and risk to the environmental and economic resources of a given coastal system. Nicholls (2007) summarised coastal erosion management policies in Figure 5.1. It is important to note that most of the time, experts combine different aspect of these polices (IPCC, 2001, 2007; Koster and Hillen, 1995 and DEFRA, 2006) to achieve sustainable coastal erosion management.

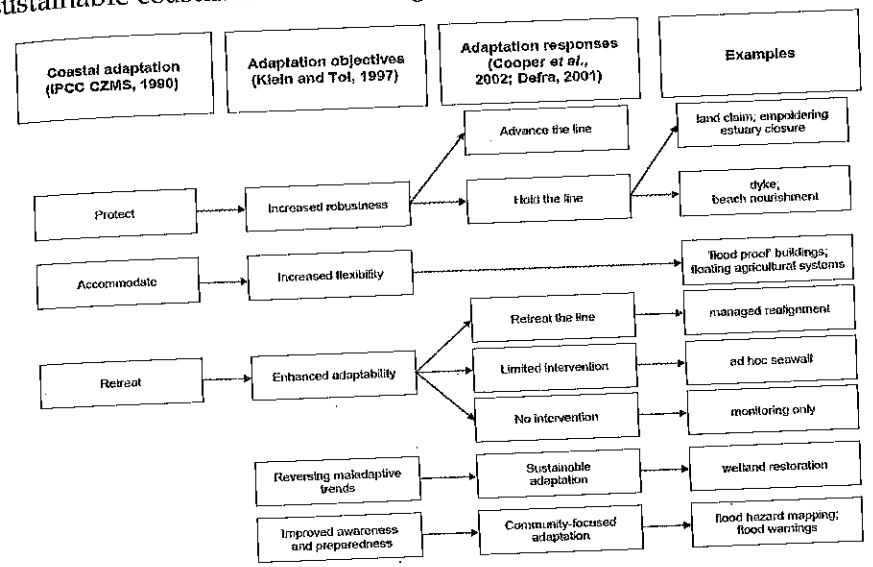


Figure 5.1: Summary of coastal erosion management policies (after Nicholls et al., 2007)

2.1 Policies and Coastal Erosion Management Approaches

Many schemes and multiple strategies have evolved over many years of fighting between humans and coastal processes. While some of the coastal protection schemes have been developed from results of painstaking research, others have been learnt and mimic from the natural coastal defence systems. Table 5.1 below outlines some of the coastal erosion management approach with examples.

It is worth noting that coastal erosion is caused by multiple factors ranging from mechanical, biological and chemical processes.

As a result of this, combinations of different approach outlined in Table 5.1 are mostly employed to manage erosion. The various approaches outlined above could be divided into hard and soft engineering approach. Figs. 5.2 and 5.3 provide a sketch of soft and hard engineering approach respectively.

2.2 Local and Regional Cooperation on Coastal Erosion Management

Coastal and marine environment and physical processes that shape the coast do not conform to political administrative boundaries both local and international. Physical processes that evolve coastlines operate across local, regional and international administrative boundaries. Hence any artificial intervention that interfere with a transnational coastal processes is likely to have serious impact on adjoin countries downdrift and updrift.

In the UK, the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) (Environmental Agency, 2011) have published a "pre-emptive" national flood and coastal erosion risk management strategy for England to ensure that government, the Environment Agency, local authorities, water companies, internal drainage boards and other organisations that have a role in flood and coastal erosion risk management (FCERM) understand each other's' roles and co-ordinate their effort in the management of these risks. The English national strategy sets out what needs to be done to manage flood and erosion risks by improving understanding of coastal processes, reducing the likelihood of incidents happening, as well as managing the potential consequences to people, businesses, infrastructure and services. Using the strategy, all the organisations listed above will work together with communities to manage the risk of flooding and coastal erosion to people and their property. Over time, they will be able, where possible, to improve standards of protection and help householders, businesses and communities better understand and manage the flood and coastal erosion risks they face.

Table 5.1: Summary of coastal erosion management approaches

Policies	Approach	Brief description	Example
Retreat	Adaptive management	It involves relocation and allowing natural processes to evolve the coast. Thought it is a do-nothing approach, it may often be appropriate to implement short term works to manage and repair storm related erosion within a longer term policy of controlled adaptation. It allows the natural processes and ecosystem of an evolving dune system.	 (Source: Scotish National Heritage)
Accommodation	Dune grass planting	This approach involves the growing of natural dune grasses to act as wind break to reduce wind speeds across the surface, thereby trapping and holding sand. Marram grass is particularly effective as it positively thrives on growing dunes and grows both vertically and horizontally as the sand accumulates.	 (Delaware's sand dunes: Source, Michael Powell,)

ble 5.1 continued: Summary of coastal erosion management approaches

commodation	Dune fencing	This involves the erecting of close fences along the seaward face of dunes to intercept windblown sand and encourage the deposition entrain sand to reduce erosion. A variety of fencing materials can be used successfully to enhance natural recovery.	 Massachusett coast.
commodation	Beach recycling	It is a soft engineering technique which involves the extraction and shifting of sand, shingle from an area of accretion to an area of erosion. The process facilitates natural recovery.	 Seaford Beach recycling, Sussex, UK
ommodation	Sandbag structures	This involves the use of sand bags of various sizes as temporary reefs, breakwaters, groynes, headlands or revetments on sand beaches.	 Google image

Google image

Table 5.1 continued: Summary of coastal erosion management approaches

Accommodation	Beach nourishment	Beach nourishment or beach recharge refers to the importation or dredging of sand or gravel to re-feed a beach due to erosion. If the source of material is local and related by coastal processes to the eroding area then this approach is known as recycling.	 Google image
Protection	Gabion revetments	This approach involves the filling of wire mesh baskets in-situ with cobbles or crushed rock. Gabions are flexible and porous they can absorb some wave and wind energy, thereby reducing the scour problems associated with impermeable sea defence such as concrete seawalls.	 Google image
Accommodation	Artificial reefs	This approach involves construction of rock mound structures parallel to the shore to dissipate part of the incident wave energy before it reaches the dune face, thereby protecting the upper beach from erosion and encouraging deposition. Artificial reefs may be long single structures or form a series of reefs extending for some distance alongshore. The different from nearshore breakwaters because reefs are submerged and are therefore less intrusive on the aesthetics view of the coastal landscape.	 Google image

ble 5.1 continued: Summary of coastal erosion management approaches

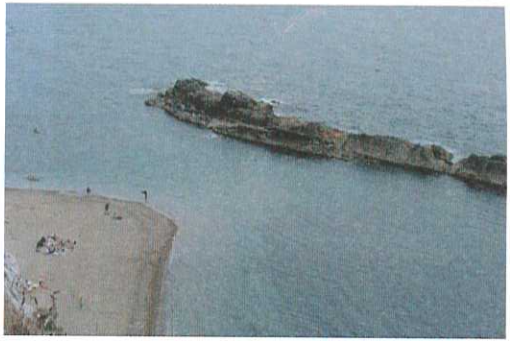
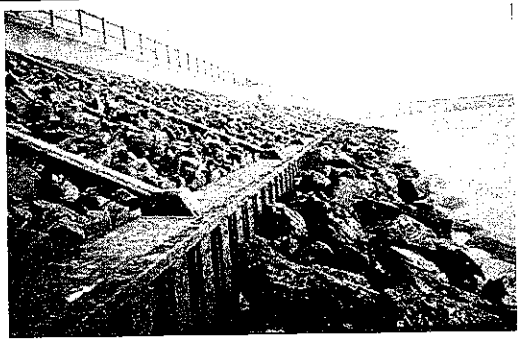
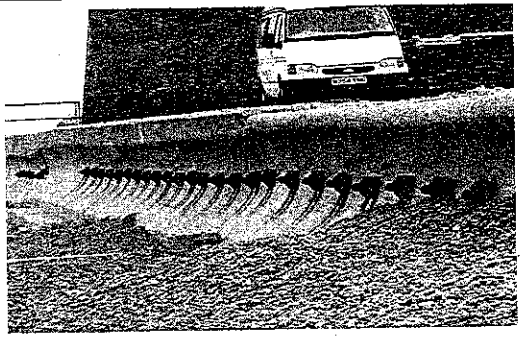
tection	Nearshore break-water	It involves the construction of a rock armour or concrete structure parallel to the shore at high water mark to reduce the energy of waves reaching the shoreline. The structures act as a direct barrier to waves, but at very high water levels they allow some overtopping.	 Dorset, UK
ection	Groynes	They are cross-shore structures designed to intercept longshore transport on open beaches thereby reducing erosion. On an open beach they are normally built as a series to influence a long section of shoreline that has been nourished or is managed by recycling.	 Sheringham beach, UK

Table 5.1 continued: Summary of coastal erosion management approaches

Protection	Revetment	This may be a carefully designed engineered structures or rock armour built at the beach face to control erosion. Revetments can be timber, rock or concrete. They dissipate the energy of storm waves and prevent recession of the backshore. Rock revetments are widely used in areas with important backshore assets subject to severe and ongoing erosion	 Scottish Natural Heritage
Protection	Seawalls	These are near vertical structures of concrete, sheet piles, designed to withstand severe wave attack.	 Sheringham recurved seawall, UK

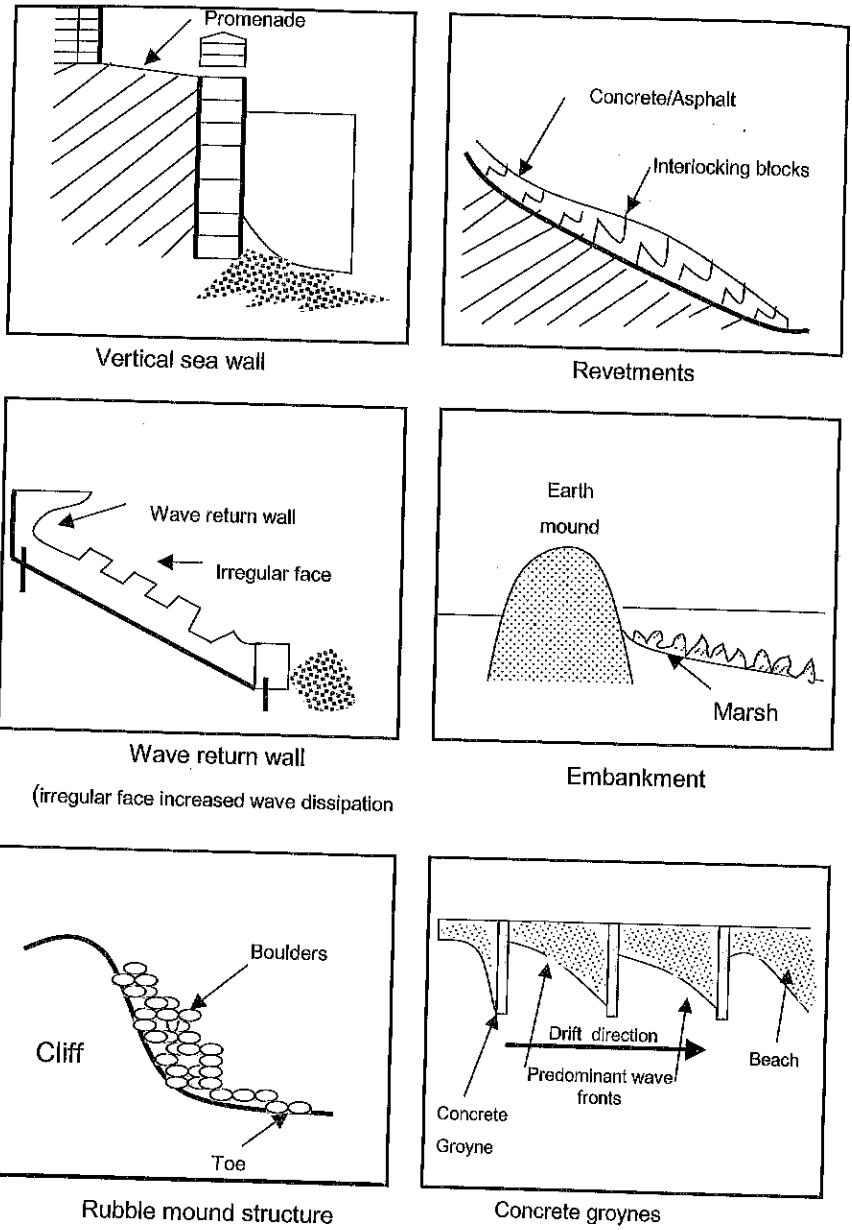


Figure 5.2: Examples of hard engineering approach.

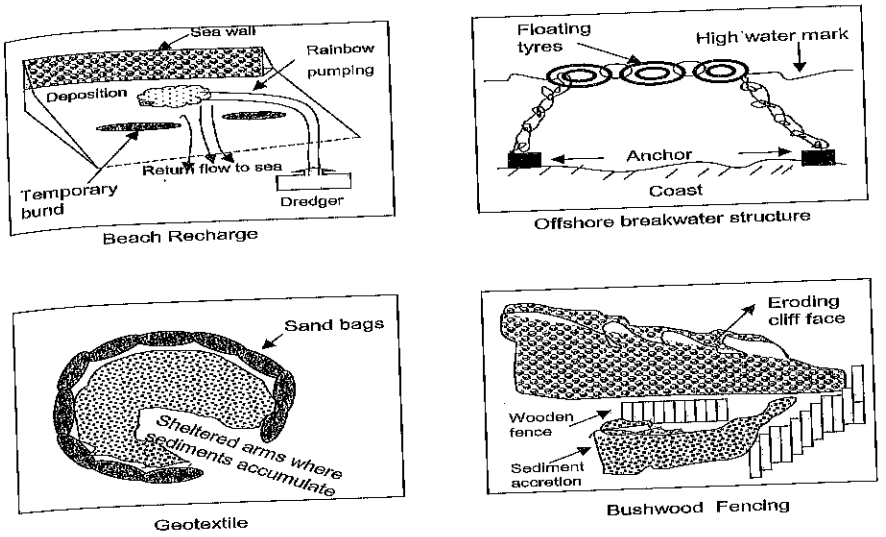


Figure 5.3: Examples of soft engineering approach.

This integrated erosion and flood risk management strategy helps bring together government and the local authorities (district assemblies in Ghana) who are responsible for managing these risks with the organisations, communities, and people who are at risk. In summary, the strategy encourages them to work together to:

- develop knowledge on when and where flooding and coastal erosion is likely to happen,
- make sure that any flood and coastal risk management plans use the most up-to-date information and raise awareness of these risks among affected communities,
- reduce the chance of harm to people and damage to the economy, environment and society by building, maintaining and improving flood and coastal erosion management infrastructure and systems,
- avoid inappropriate development in areas of flood and coastal erosion risk,
- improve the detection and forecasting of floods and how warnings are issued, so that people, businesses and public services can take action, plan for and coordinate a rapid response to flood emergencies,

- take opportunities to work with and enhance communities, services and the natural environment (Environmental Agency, 2011).

Ghana and ECOWAS could learn from the English example and pursue both local and regional coordinated approach to deal with the coastal erosion issues in their local and cross-boundary environment. For example, there is a strong west to east littoral drift along the West African coast. As a result, sometimes coastal intervention in local jurisdiction or one country could have a serious repercussion in the adjoining countries downdrift. For instance, a complete interception of the littoral transfer by constructing long groynes at the Ghana's eastern border town, Aflao, might reduce or stop the transfer of sediment downdrift. This is likely to cause severe erosion to the coastline of Togo and Benin that seems to benefit from the down-drift transfer of sediment (Blivi *et al*, 2002). It is reasonable to suggest that integrated approach and perhaps an international effort is required to develop a sustainable management solution to the issue of coastal erosion at the eastern coast of Ghana, since any measure aimed at intercepting large amount of the littoral transfer at the eastern boundary of Ghana would have significant effect on the coast of Togo and Benin.

2.3 The Case Study of Coastal Erosion Management in Ghana

Coastal erosion poses serious threat to life and properties along Ghana's coast. In spite of this threat, management strategies and policies, both past and present, remain an "ad hoc" and site specific (Boateng, 2006). In fact, management of coastal erosion in Ghana and many West African countries have largely focused upon provision of hard protection at specific "high risk" locations. There has been little commitment to the concepts of integration of management interventions with wider natural processes and long-term sustainability. As a result coastal protection schemes in Ghana (Keta, sea defence and Ada sea defence) protect sections under threat and exacerbate the situation elsewhere along the shoreline (knock-on effects) (French 2001). Such problems have occurred previously on many other developed coastlines in the world and

more holistic coastal erosion management policies in recent decades (DEFRA, 2006; IPCC, 2001; Koster and Hillen, 1995).

Furthermore, limited attention has been given to research on coastal process and morphology as well as large scale assessment and investigation to detect the rate of coastal recession and the size of land lost to the sea to inform integrated management plan for the entire coastline (Boateng, 2012b). These are the basis for the formulation of sustainable management policies and strategies to deal with the problems in Ghana.

One important observation of coastal erosion management policies and strategies in Ghana is that it is "reactive" rather than "pre-emptive" and mostly hard engineering rather that soft engineering approach. There is no national holistic plan or management policy that have been developed in advance to either manage erosion along the shoreline or to reduce effects of coastal erosion on life and properties in advance. In most cases, government and local authorities response to the call of local communities who are being displaced by the impact of coastal erosion. Keta sea defence, Nkontompo rock armour and the recent Ada coastal protection are typical example of this kneejerk coastal erosion management policy in Ghana.

In addition, coastal defence schemes in Ghana are mostly funded by international loans. In most cases, these countries make bringing in their experts to implement the scheme part of the loan agreement. Sadly, these international experts tend to prescribe wrong solutions. This may be due to following reasons:

- lack of knowledge of coastal processes on a regional scale,
- limited involvement of local experts, and
- their quest to prescribe an expensive scheme so as to maximise profit.

Boateng, (2012a) appraisal of coastal adaptation options suggested that protection with hard defences should be confined to a necessary minimum. Where hard defence structures are necessary, effort should be made to reduce the "knock on effect" of the defence structure on the adjoin coast.

These and other factors such as damming of major rivers that supply sediment to the beach and port development has led to high rates of coastal recession at most developed sections of Ghana's coastline (Boateng *et al*, 2012; Appeaning Addo *et al*, 2008; Wellens-mensah, 2002 and Ly, 1980). The high rate of coastal erosion has not had huge deleterious impacts on the coastal development due to large coastal buffer land that exists between the coast and developments. For instance, some sections of the coastal towns have about 100 to 300 m wide strip of largely undeveloped coastal buffer lands laying between the intensive built areas and the sea front. These buffer zones seem to have significantly reduced the effects of the rapid recession rate in key urban frontage like Accra, Elmina, Takoradi and Sekondi.

The coastal buffer land was not created by modern town planning, but through historical perception of the coast. First, the perception of coast as slave trading grounds and the fear of being seized by force and sold into slavery, and second, the preference to live some distance inland where the land is fertile for cropping rather than the highly porous and salty beaches and barriers along the coast. These two factors have prevented settlement close to the sea in the past. Today, however, all the myths and the traditions about the coast have changed. The coast of Ghana, particularly, the urban areas are viewed as an amenity and economic asset. Property developers have begun acquiring the coastal buffer lands, and recreational facilities are encroaching along the frontage. These latest development along the coast causes much concern because if more development are allowed on the coastal buffer lands, it may lead to increases demand for coastal defence in the future, which may have severe economic cost and environmental consequences on the shoreline.

3.0 Conclusion

Coastal erosion is caused by complex physical process involving many natural and human-induced factors (French 2001). The natural factors include such variables as effects of waves, tides, wind, current, sea level, sand sources and sinks; changes in relative sea level; geological characteristics of the shore; bathymetry; sand size

density, and shape; sand-sharing system of beaches, dunes, and offshore bars. Human intervention alters these natural processes through such actions as the dredging of tidal entrances, construction of harbours in nearshore waters, construction of groynes and jetties, hardening of shorelines with seawalls or revetments, construction of sediment trapping, upland dams, and beach nourishment (National Academy of Sciences, 1990).

The scientific understanding of the coast as a dynamic environmental system in which land and sea constantly interact has changed the perception of coastal erosion management from hard engineering structures (which tend to interfere with the natural processes through stabilisation of the coastal) to soft engineering approach which attempt to work with natural processes to enhance natural resilience of the coast. This major paradigm shift of coastal erosion management policies has not been developed or applied in Ghana and other West African countries. The review above have shown that the old coastal erosion management policies and approach are not sustainable. It is therefore need for Ghana and her neighbours in the sub-region to develop strategies to adapt and implement the new coastal erosion management policies for the sustainable management of the shoreline.

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